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Floating Gas-to-Liquids Technology Unlocks Difficult Reserves

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Development of miniaturized gas-to-liquid technology is moving toward shipboard applications for remote fields and infrastructure- poor areas.

Floating liquefied natural gas (FLNG) facilities are a type of floating production, storage and offloading (FPSO) system for natural gas rather than oil. The FLNG concept has been in the industry in one form or another for several decades. In fact, the first plant was installed on a river barge in southern Louisiana in 1951. However, an FLNG facility has never been utilized offshore.

Liquefied natural gas (LNG) technology has evolved considerably during the past 50 years, resulting in more efficient and smaller LNG facilities. This evolution is lending itself to miniaturization required for a floating LNG facility. Inside Shell, FLNG technology is considered to be at the project ready stage, meaning enough research and development has been conducted that the concept is ready to go into detailed engineering design for a specific project in the near future.

Detailed engineering design would be performed to construct an FLNG facility specific to, among other things, the feedgas that would be available, the amount of liquid associated with the field such as crude and condensates and issues surrounding the sea state in which the FLNG facility would be moored.

The FING facility is ship-shape and similar in size to an FPSO. Like an FF"SO, subsea wells would be connected to the FING facility. It would have a turret-type mooring system at the bow, allowing the vessel to weathervane into the wind and waves.

Also, like FPSOs today, an FLNG facility could be redeployed to other fields when the field project is depleted. Extensive Shell research indicates the health and
safety profile of an FLNG facility is similar to the best North Sea platforms and FPSOs worldwide. In fact, FLNG facilities may be inherently safer than an FPSO, since gas treatment equipment is closest to the bow while crew accommodations are located at the stem. Also, use of electric compressor drivers rather than the standard gas turbine direct drive compressors onshore are safer in offshore applications and provide improved redundancy and ease of maintenance.

One advantage of applying LNG technology to offshore facilities is the two-way technology street. Some of the technology enabling FLNG can be applied to onshore plants as well, resulting in lower costs of the onshore facility plus more efficient operations.

Two potential areas for Shell

An FLNG facility is not an alternative application everywhere in the world. What impacts cost savings most is the ability to eliminate moving the gas ashore via pipeline and then building an onshore plant. However, if the host country has good local infrastructure and low costs, the onshore plant will remain a viable alternative as long as the offshore gas is not too remote.

Two areas Shell is examining for the possible first use of FLNG facilities are offshore Namibia in western Africa and in the Timor Sea between Indonesia and Australia. Since seas are rougher toward the southern tip of Africa, loading likely would take place in a tandem arrangement during harsh weather periods. In the more benign Timor Sea, a standard LNG vessel side-by-side loading arrangement would provide reliable year round access.

Shell, while working toward the possible application of FLNG facilities in these two areas, has not yet made a final investment decision, as there are many other issues to be considered.

In the possible Timor Sea application, the FLNG facility could be moored as far as 248 miles (400 km) offshore. In this case, utilizing an FLNG facility is driven predominately by cost. "The advantage is having a single floating facility that services both production processing needs as well as gas liquefaction, LNG storage and offloading," said Rob Ryan, vice president of gas business development for Shell E&P. This is compared with the alternative of an offshore development, plus a 248 miles (400-km) pipeline to an onshore processing plant with LNG storage and an export terminal.

"The advantage in such a case where you are quite remote is obvious and the cost savings will often determine project viability.

There are other potential applications in Australia, and West Africa is also considered a good area for FLNG application in the near term," Ryan said.

There are, of course other much harsher metocean environments that could eventually end up with FLNG facilities as the technology is deployed and operating confidence and experience is gained during the next 10 years or more.

There also are areas that while easily acceptable from a technical perspective, probably would not be cost-effective FLNG applications due to the amount of transportation infrastructure already in place. This is true for most of the Gulf of Mexico, where even in deepwater, most new developments would not be very far from existing gas infrastructure.

Reduced to fit

"The evolution in the LNG industry, particularly in the way Shell designs its LNG facilities, is what has essentially enabled a floating application," Ryan said.

A key building block was the development of our proprietary Dual Mixed Refrigerant process. This development reduced the overall

equipment count of the liquefaction process by about 30% and has the particular offshore advantage of not requiring the propane cycle."

The Dual Mixed Refrigerant (DMR) process is a Shell proprietary process combining plant simplification and enhanced safety. This technology also has the advantage of operating on more flexible specifications regarding feedgas and refrigerant.

For offshore facilities, DMR is self-contained, meaning it generates its own refrigerants on the FLNG facility. DMR does not require the initial fill and replenishment of costly propane produced onshore and then transported to the FLNG facility.

Eliminating the use of propane and butane storage and export in Shell's FLNG design also enhances safety.

The refrigerant consists of two process strings sharing certain components, which results in further cost savings, smaller equipment and a certain amount of redundancy. Should one compressor need to be taken off line, the entire liquefaction unit does not have to be shut down but instead can operate at a reduced level while repair or maintenance is being performed.

The DMR also reduces carbon dioxide emissions by 40% when compared with the well-known cascade process and by 20% compared with the common propane precooled mixed refrigerant process.

The future: Oil and gas processing facilities in one?
One concept maturing inside Shell deals with an oil field solution, where the oil reserves and associated natural gas production is often too small to justify both a dedicated FLNG facility and an FPSO. Re-injecting the gas is expensive and in some cases may not be practical given the reservoir conditions.

Flaring the gas also is not an option.

"Shell believes the answer is a unique combination of FPSO and FLNG technology in a single floating facility that accommodates the oil production along with a smaller LNG train to handle the associated gas," Ryan said.

Shell has matured this concept to the point they are ready to commence pre-FEED (Front End Engineering and Design) studies with a focus on a couple of potential West Africa applications.

"The key enabler for our Floating Oil and Natural Gas solution, called FONG, is its unique product management system, for which Patent applications were filed in late 2001," Ryan said.

The well stream fluids are processed and treated to store and export only two products, crude oil and LNG, without the need for flaring or separate LPG (propane and butane) storage and offloading.

The LNG process is similar to peak shaver plant designs with nitrogen refrigerant to provide a low risk small-scale plant that

can be installed on an FPSO. The FONG vessel is similar in size to a FLNG and contains storage for 1.4 million bbl of crude oil and 160,000 cu m of LNG. This ensures the LNG could still be loaded out to a standard LNG tanker. The innovative FONG solution, with its unique product management system, enables economic development of a greater range of oil accumulations in more difficult environments than possible with FPSO and gas injection solutions alone.

Whatever the configuration, the development of FLNG and FONG are significant steps forward to greater range of oil and gas accumulations in deeper and more remote offshore locations.

Shell's extensive experience and in-house expertise in FPSOs and decades of experience manufacturing, storing and transporting LNG means its FLNG concepts are technically sound. It is likely Shell's concept will become reality in only a few short years.

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